Seeking varieties for more sustainable cereal production

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SAC cereals specialist **Steve Hoad** used a Farmers Club Charitable Trust bursary to study how new varieties could be evaluated for more sustainable production in Europe.

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WORLD agriculture faces the challenge of increasing crop production to feed a growing population, whilst at the same time sustaining the environment and natural resources. Plant breeders are the key players in meeting this challenge – not only in improving yield and food supply, but also for delivering new varieties with wider social and environmental benefits.

My study took me to Germany and France to meet cereal breeders from Saaten Union, an alliance of seven plant breeders headquartered in Hannover with more than 20 breeding stations and over 100 testing sites in and outside Germany, including France, Denmark, Hungary, the Czech Republic and the UK.

This pan-European approach (see panel) helped me study crop adaptation to climate change and the need to improve the ability of crops to utilise resources more efficiently.

Before meetings breeders were sent a series of questions about their work and the challenges facing agriculture, including political drivers such as responding to climate change targets and reducing environmental impacts. Further questions prompted debate about how best to evaluate the public-good of new varieties.

Although each breeder had a different approach, as well as original thoughts on agricultural sustainability, common messages emerged.

Introducing wider sustainability criteria into new crops means a requirement for:

- adaptation to climate change
- more resilient crops to ensure food security
- plant traits to reduce harmful environmental impacts of farming.

The most important resources available to a breeder's success are new sources of genetic material and the 'core' environments in which they select and test their varieties.

Old landraces can provide useful genetics

Europe's breeders are making good progress towards more sustainable varieties - Steve Hoad of SAC

Genetic improvements come from crossing elite parents or other plant types such as old varieties, 'exotic' varieties or landraces. Extra genetic variation comes from seed banks and through the use of new genetic technologies to enhance diversity in desirable traits.

Breeders have their own strategies to identify the best selection sites, with the location of core sites having a big impact on a breeder's success in achieving wide adaptation and maintaining competiveness in the market.

Generally, genetic resources are well used across breeding programmes, with increasing diversity in the range of material used. However, there is scope for improvement. What is most important is having a systematic approach to measuring or screening new plant material under field conditions, something breeders cannot do alone. The research community has a role to play too.

Continued yield improvements are expected and it is likely that cereal yield potential will continue to increase at 1% per year. On farm, however, the picture is very different and in recent years crop yields have almost stagnated.

This discrepancy is often attributed to minimal limitations on yield in the small plots used by breeders and variety testers, compared to the highly variable conditions in farmers' fields.

To make progress, breeders might have to select differently, and cover a wider range of conditions, whilst farmers require more help to alleviate highly variable conditions in soil quality, disease or pest levels and nutrient supply.

Climate change

In many parts of Europe, approaches to cereal breeding programmes will not need to make major changes to keep pace with predicted climate change. However, where changes include a temperature rise of several degrees centigrade, or where seasonal variation becomes more extreme, plant breeders will need to introduce much more genetic diversity to cope with shifts in temperature and soil moisture.

If temperature rises are at the upper levels predicted then agriculture in some regions will need to consider whether it should continue growing the same crop species. Under this scenario, adjusting crop rotations to sustain agricultural production will impact on the activities of plant breeding and will also become an important political issue.

The proposal that breeding and variety testing could include wider sustainability criteria was discussed throughout the study tour. At present, successful varieties are characterised by high yields in response to fertilisers, fungicides and plant growth regulators and without competition from weeds. In future, evaluation could go beyond the long-established criteria for yield and quality improvements, with environmental criteria becoming as important as the more obvious economic considerations.

Sustainability

To a large extent sustainability traits already exist in cereal varieties. But at present we do not, or cannot, evaluate them. A clear possibility in the near future is for varieties to include traits such as increased efficiency of nutrient use or good performance at reduced fertiliser inputs. Added nutritional value is also likely, as are much improved pest and disease resistances, both of which would make crops cheaper to grow and reduce the risk of poor yields.

At present, the production of inexpensive food and environmental benefits of agriculture appear to be in conflict, because of the high input nature of modern agricultural production. However, these aspects could converge over time, if the whole of agricultural production, including plant breeding and variety testing, embraced a more holistic approach.

Publically funded science has made significant advances in understanding the genetic basis of plant growth and developmental processes, especially in model species. New collaborations and funding are required to apply this scientific knowledge to practical plant breeding.

My insight into the workings and aspirations of plant breeders in crop improvement and variety testing during this study will be of considerable value to future research and extension work. Its findings should now hand over to others in the supply chain, including the wider plant breeding community and the official variety testing authorities.

In doing so two important questions arise:

- Is there a trade-off between breeding for yield and quality improvements and traits with wider public-good value?
- Who pays for the extra costs incurred by breeders and variety testing systems when assessing additional public goods attributed to new varieties?

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Rigorous assessment is key to identifying new traits

Areas Visited

- Hannover, Saaten-Union headquarters
- Söllingen and Böhnshausen in Lower Saxony/Saxony-Anhalt (the old east-west border region). Although only 40km apart these locations provide a rich diversity of selection environments for the breeding of wheat and other crops such as sugar beet.
- Irlbach, north of Munich in Bavaria. The focus here is spring and winter barley, with a continental climate and the Alpine *föhn* wind – known locally as the "hair dryer" as it delivers very hot dry air.
- Estrées Saint Denis in Picardy, north of Paris, where the breeding focus is on wheat for north-west Europe, with an eye on the UK market.